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Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Research Document 90/8

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Comité scientifique consultatif des
pêches canadiennes dans l'Atlantique

CSCPCA Document de recherche 90/8

An estimate of Capelin (Mallotus villosus) biomass from an acoustic survey conducted in NAFO Divisions 2J3K in October, 1989

by

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Abstract

Acoustic surveys of the capelin stock in NAFO Divisions 2J3K have been carried out on an annual basis since 1981. This paper summarizes the results of the survey conducted in October 1989, and provides an estimate of biomass and age structure for the stock. A summary of the distribution of capelin over the historical period of the acoustic surveys is also provided.

Résumé

Depuis 1981, on effectue chaque année des études acoustiques du stock de capelan des divisions 2J3K de l'OPANO. Le présent document résume les résultats de celle qui a été réalisée en octobre 1989 et fournit une estimation de la biomasse ainsi que la structure d'âges du stock. On y trouve aussi une description sommaire de la distribution du capelan depuis 1981.

Introduction

An acoustic survey of the NAFO Division 2J3K capelin stock was conducted from the research vessel GADUS ATLANTICA during the period October 10-28, 1989. Two and three year old capelin of the 1987 and 1986 yearclasses were predominant in the acoustic estimate. Biomass was estimated at 1744 thousand metric tons.

Methodology

The equipment configuration of the acoustic data acquisition system (HYDAS) was the same as for the 1988 survey (GADUS 158) with the exception of the transducer which was changed. The calibration parameters were as follows:

Combined SL + RS	51.77 dB
Fixed receiver gain	5.57 dB (Run #1)
	9.96 dB (Runs 2-54)
TVG gain	20 log R
Attenuation coefficient	.0120 dB/meter
Pulse length	600 milliseconds
Bandwidth	3.3 kHz
Sampling threshold	50 millivolts
Average beam pattern	-29.36 dB
Target strength	-34 dB/kg

A receiver amplifier board had to be changed in the Simrad EK400 after the first run in the survey resulting in a change in the fixed receiver gain parameter.

Data presented at the February, 1989 Pelagic Subcommittee meeting (Carscadden et al. 1989) from groundfish stratified trawl surveys indicated that in certain years, capelin occurred to the east of the area traditionally covered by the capelin acoustic survey. Consequently, the area covered by the 1989 acoustic survey was extended eastward to the 500 meter depth contour which is the limiting depth that HYDAS can operate in. As recommended by the Pelagic Subcommittee of CAFSAC (O'Boyle and Atkinson 1989), transects were selected in the survey area following a random parallel design. Figure 1 shows the survey blocks, acoustic transects, and fishing set locations for the survey. Estimates of mean biomass and variance for the survey were calculated as for the 1988 biomass estimate (Carscadden et al. 1989). As noted for the 1988 survey, these formulas account only for the variance attributable to the sampling design and do not take into account any error in the target strength value used or the measurement of the calibration parameters of the acoustic data acquisition system.

Fishing sets were made on an opportunistic basis throughout the survey. It was attempted to have at least one set for each twelve hour watch and at least one set for each transect. A random sample of 200 capelin was obtained from each midwater trawl set for length, sex, and maturity observations and a stratified age sample was selected from each length/sex/maturity sample. Length composition and an age/length key was constructed for each stratum from the samples obtained in that stratum.

Results

Table 1 gives the results of estimating the acoustic backscatter and biomass for each strata and for the total survey. Total biomass was estimated at 1,744,652 metric tons with a coefficient of variation of 0.187. Table 2 provides estimates of backscatter and biomass for each acoustic transect and shows the distribution of the

biological sampling amongst the acoustic transects. Table 3 gives the total age composition for the historical period of acoustic biomass estimates. The 1986 yearclass is still strong in the biomass estimate and the 1987 yearclass also appears to be better than average. Biomass and numbers for the 1987 and 1988 surveys were reduced by a factors of .8375 and .7396 respectively due to changes made in the combined source level/receive sensitivity parameters for these surveys (Lang and Stevens 1990 (in press)). Table 4 provides for each strata, the percent at age by number, the mean length at age, total numbers and mean length and the number of samples used.

Figures 2 to 9 show the distribution of capelin encountered during acoustic surveys over the period 1981 to 1989. The data was gridded and contoured using the PC software package 'SURFER'. The minimum contour level (10g's/sq. m) and interval (20g's/sq. m) are the same for all years. The figures clearly show that the area between latitude 52°30' to 55°00' accounts for the majority of the capelin biomass in most years. The area to the eastward between latitude 50°00 and 52°30' does not appear to contain significant concentrations of capelin. This is where the expansion of survey coverage was made in 1989 but for this year at least, it does not make any difference to the total survey biomass estimate.

Prognosis for 1990

The estimates of year-class strength from this acoustic survey can be used as a basis for projections. Spawning mortality and proportion mature were from Carscadden et al. (1985). Mean weights were from all available data. The following parameters were used in the projections:

Age/year	Spawning mortality	Proportion mature	Mean wt. (g) inshore (mean 1979, 1982-89)	Mean wt. (g) offshore (mean 1972-89)
2				17.0
3	1.39	.22	29.9	23.8
4	1.69	.64	37.3	27.5
5	2.23	.77	35.1	30.7
6	2.23	.89	36.7	34.5

The results of the projections using the above parameters together with M = 0.30 (between spawning periods) and a spawning date of 1 July are given below.

Age	Number of fish (billions)		
	November 1, 1989	July 1, 1990	September 1, 1990
2	59.0		
3	35.3	48.3	38.3
4	2.5	28.9	13.1
5	0.5	2.0	0.7
6		0.4	0.1
Mature biomass (t)		1,073,000	
Total biomass (t)			1,295,000

No estimates of the 1988 year-class are available. However, if the geometric mean (N = 8) of age 2 estimates from the Canadian acoustic surveys is calculated, the value is 22 billion fish and 374,000 tons for September 1, 1990.

Acknowledgments

R. Harnum and B. Slaney assisted in the collection of the acoustic data and the biological samples from the midwater travl sets. C. Stevens, C. Lang, G. Mason, and G. Pike set up and calibrated the acoustic data collection system (HYDAS).

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Carscadden, J. E., D. S. Miller, and G. R. Lilly. 1989. Capelin in SA2 + 3K: Results from offshore research. CAFSAC Res. Doc. 89/78.

Carscadden, J. E., G. H. Winters, and D. S. Miller. 1985. An indirect method of estimating maturation rates of capelin (Mallotus villosus). J. Northw. Atl. Fish. Sci. 6: 135-140.

Lang, C. C., and C. R. Stevens. 1990. Adjustments required to hydroacoustic calibrations of the HYDAS system from May 1987 to February 1989. CAFSAC Res. Doc. in preparation.

O'Boyle, R. N., and D. B. Atkinson. 1989. Hydroacoustic survey methodologies for pelagic fish as recommended by CAFSAC. CAFSAC Res. Doc. 89/72.

Table 1. Backscatter and biomass for each strata and total survey

Strata	Transects sampled	Number of possible transects	Transect area (km^2)	Transect area scattering coefficient (sr^{-1}) Mean	S.E.	Strata total backscatter (m^2/sr)	Biomass per transect (tons) Mean	S.E.	Total biomass per strata (tons)
I	3	25	237.0	8355	2735.5	208887	20988.0	6871.2	524701
H	3	25	319.7	5984	1244.8	149598	15030.9	3126.8	375772
G	3	25	343.0	5336	2052.4	133406	13404.0	5155.3	335101
F	3	25	309.7	589	212.6	14735	1480.5	534.0	37012
E	3	30	189.7	4102	3336.6	123057	10303.5	8381.2	309105
D	3	45	432.5	992	499.2	44656	2492.7	1253.9	112171
C	3	35	534.4	466	221.8	16307	1170.3	557.0	40960
B	3	90	574.8	43	8.0	3913	109.2	20.2	9830
Total	24	300		2315	88.3	694559	5815.5	221.9	1744652
C.V.						.187			.187

Table 2. Backscatter, biomass, and biological sampling for each transect.

Strata	Transect Number	Transect length (km)	Transect area (km^2)	Area scattering (sr^{-1})	Total backscattering (m^2/sr)	Density (g/m^2)	Transect biomass (metric tons)	# of sets	Lsms	Stratified
I	1	128.0	237.0	34	8020	85.00	20146	1	200	48
	2	128.0	237.0	56	1325	140.45	33288	1	200	46
	3	128.0	237.0	16	3794	40.21	9530	1	200	44
H	1	172.6	319.7	25	7836	61.57	19682	0	0	0
	2	172.6	319.7	20	6499	51.07	16326	1	200	55
	3	172.6	319.7	11	3617	28.42	9085	2	400	87
G	1	185.2	343.0	27	9252	67.76	23241	1	200	48
	2	185.2	343.0	13	4443	32.54	11161	1	200	40
	3	185.2	343.0	7	2313	16.94	5810	1	200	36
F	1	167.2	309.7	3	963	7.81	2419	1	200	54
	2	167.2	309.7	1	227	1.84	570	1	200	44
	3	167.2	309.7	2	578	4.69	1453	1	200	42
E	1	102.4	189.7	4	763	10.11	1918	1	200	51
	2	102.4	189.7	4	767	10.16	1927	1	200	39
	3	102.4	189.7	57	10775	142.70	27066	1	200	40
D	1	233.5	432.5	3	1228	7.13	3084	2	400	94
	2	233.5	432.5	4	1715	9.96	4308	1	200	38
	3	233.5	432.5	0	34	.20	87	0	0	0
C	1	288.5	534.4	2	906	4.26	2276	1	200	40
	2	288.5	534.4	1	291	1.37	732	1	200	43
	3	288.5	534.4	0	200	.94	502	1	200	37
B	1	310.4	574.8	0	53	.23	132	1	195	54
	2	310.4	574.8	0	50	.22	126	1	200	45
	3	310.4	574.8	0	27	.12	69	1	0	0

Table 3 Numbers (billions) and biomass (thousands of tons) at age of capelin from NAFO Division 2J3K hydroacoustic surveys.

Year	Cruise	Age	1	2	3	4	5+	Total
1989	173	Numbers	1.9	59.0	35.3	2.5	0.5	99.2
		Biomass	15.4	850.1	791.2	68.9	18.5	1744.1
1988	158	Numbers	15.8	96.0	13.6	2.0	3.9	131.3
		Biomass	76.2	1208.7	336.9	55.1	127.0	1803.9
1987	144	Numbers	0.7	4.4	0.5	0.6	0.1	6.3
		Biomass	3.9	77.8	12.0	15.1	3.0	111.8
1986	130	Numbers	0.1	6.6	12.1	1.1	0.2	20.1
		Biomass	0.7	109.9	284.1	30.2	6.0	430.9
1985	115	Numbers	1.5	54.0	13.5	1.5	0.6	71.1
		Biomass	8.4	686.6	286.3	36.7	17.8	1035.4
1984	100	Numbers	6.2	34.7	7.1	4.1	0.4	52.5
		Biomass	25.5	497.9	181.9	109.8	11.3	826.4
1983	85	Numbers	2.6	2.5	1.3	0.2	0.0	6.6
		Biomass	17.6	41.1	31.2	4.3	0.0	94.2
1981	56	Numbers	67.8	59.3	7.4	2.8	0.7	138.0
		Biomass	337.8	891.2	172.4	71.9	20.8	1494.1

Table 4. Age composition and mean length at age ,total number in billions, total mean length, and number of samples for each survey block.

Strata	Age	1	2	3	4	5+	Total N/L	Number of samples
B	%	14.8	69.2	15.2	0.8	0.0	0.7	2
	L	123	140	160	190	-	141	
C	%	15.2	79.3	5.5	0.0	0.0	3.5	3
	L	127	139	159	-	-	138	
D	%	3.8	59.1	33.8	3.0	0.3	5.7	3
	L	131	155	167	175	183	159	
E	%	0.8	75.1	22.2	1.3	0.7	18.6	3
	L	121	146	164	181	198	151	
F	%	0.5	63.6	32.6	3.3	0.0	2.1	3
	L	124	147	167	176	-	154	
G	%	2.2	63.7	33.1	0.8	0.0	19.6	3
	L	126	144	166	186	-	151	
H	%	1.6	51.0	41.2	5.1	1.1	21.1	3
	L	126	144	163	178	193	154	
I	%	0.3	49.5	47.1	2.6	0.5	28.0	3
	L	125	147	165	178	200	156	

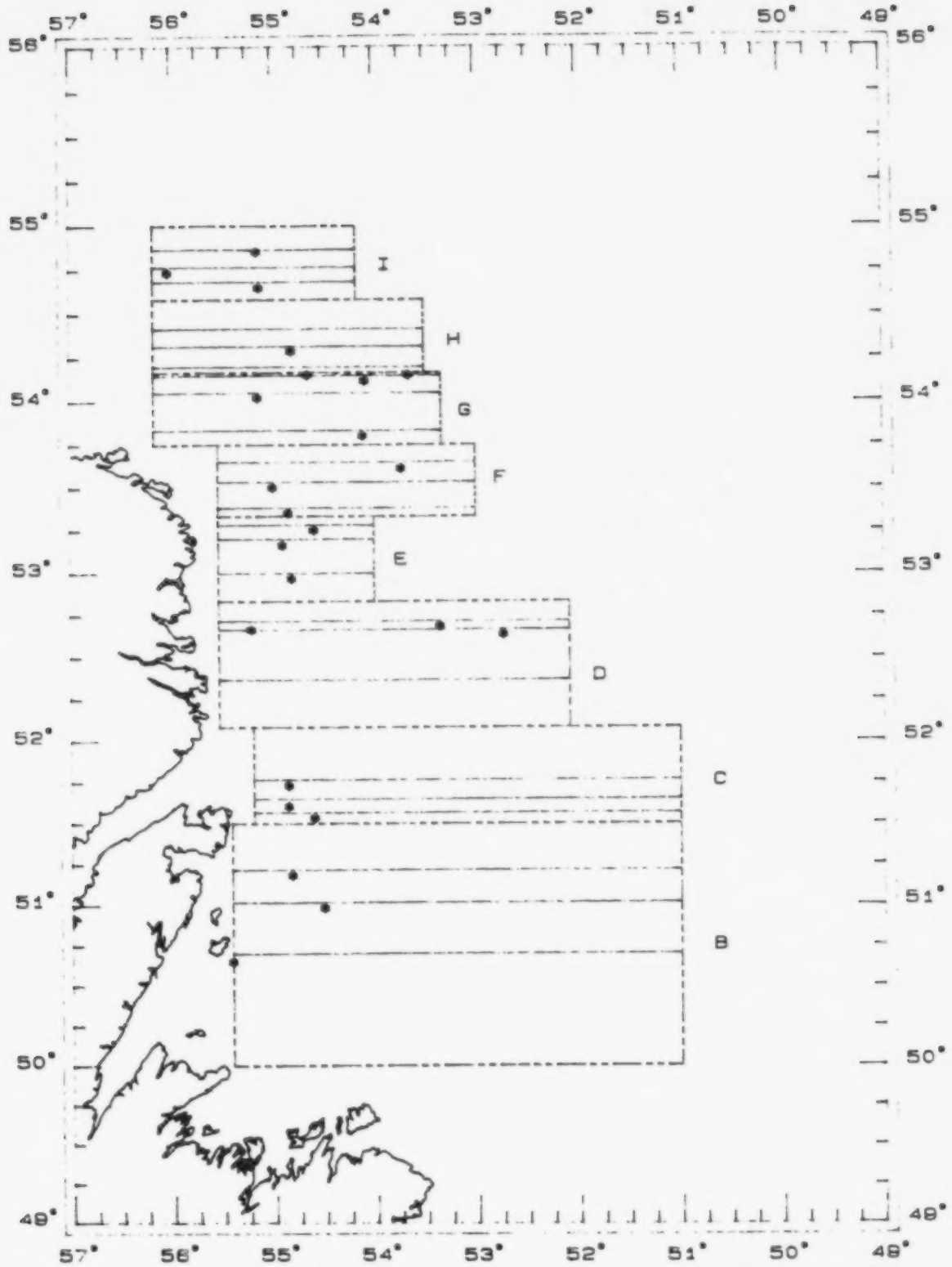

Figure 1. Strata, transects, and sets for the 1989 survey.

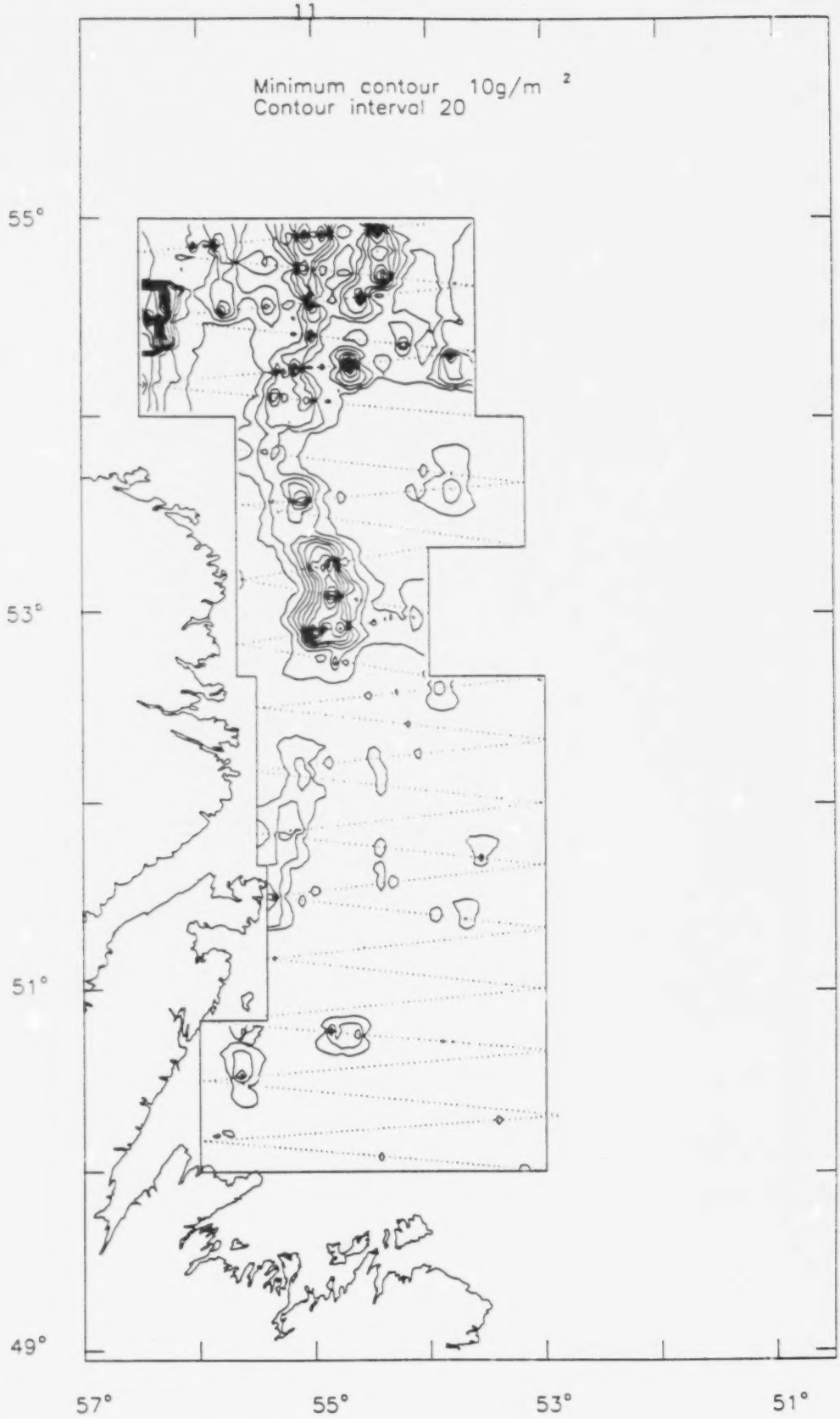

Figure 2. Acoustic capelin distribution in 1981

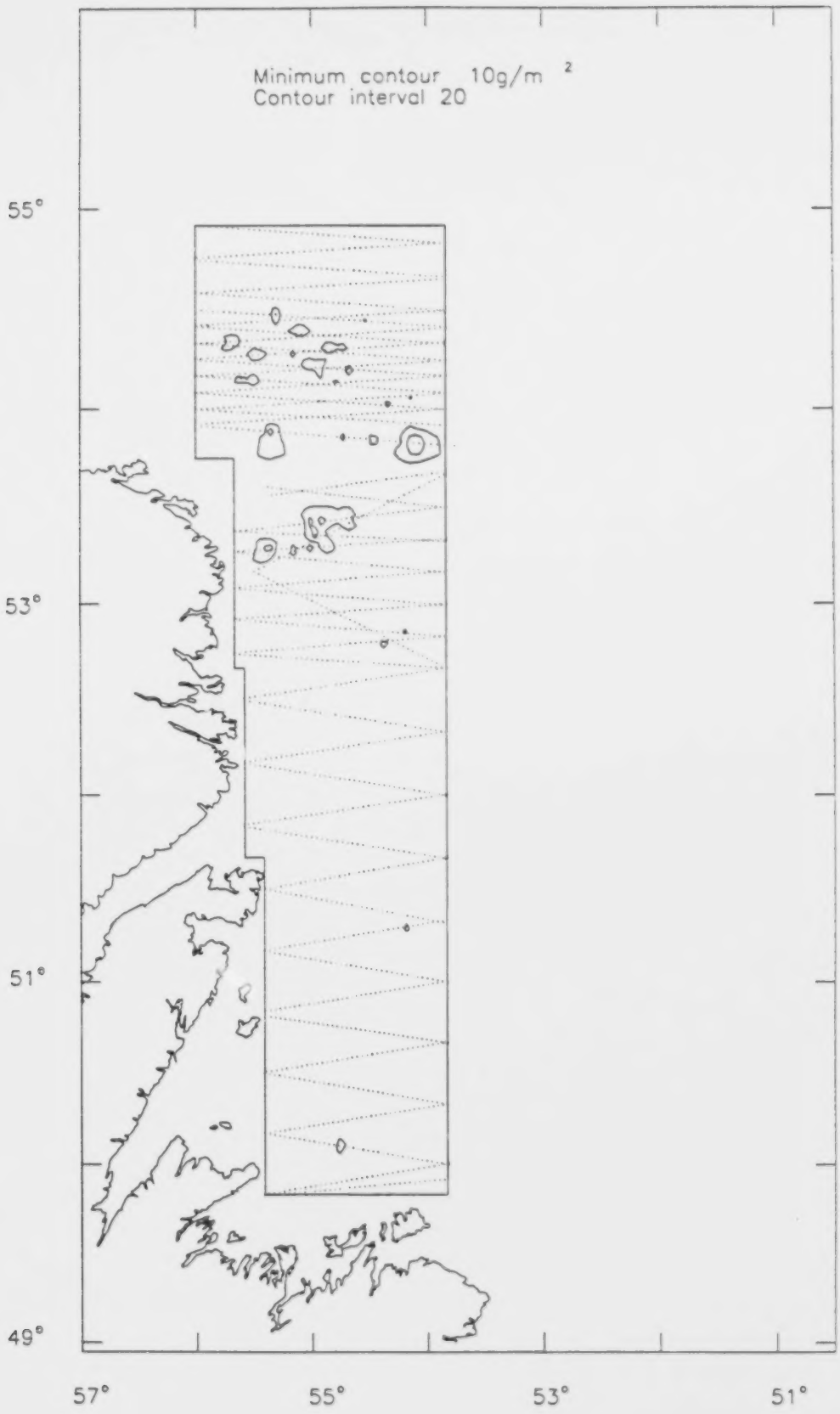

Figure 3. Acoustic capelin distribution in 1983

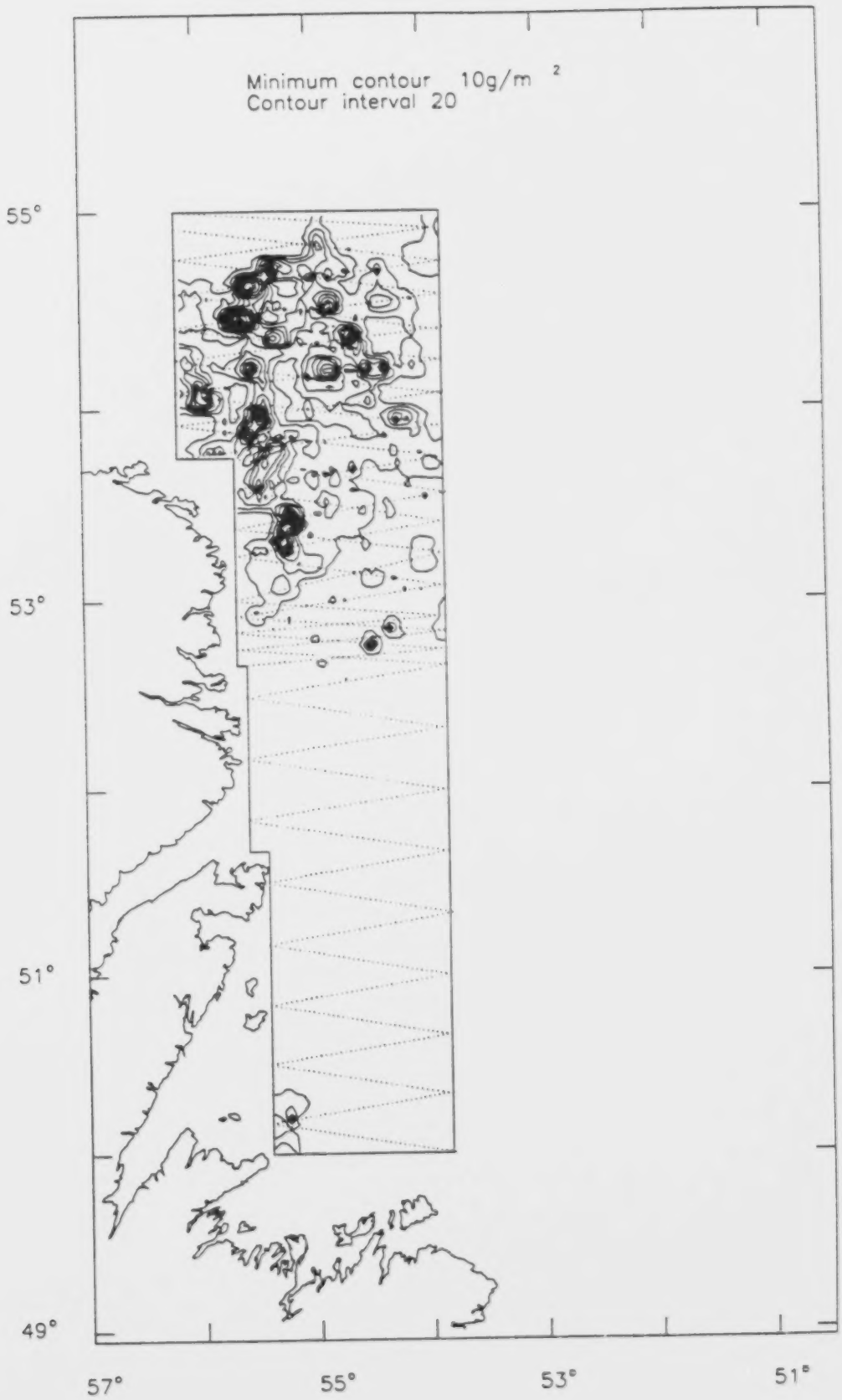

Figure 4. Acoustic capelin distribution in 1984

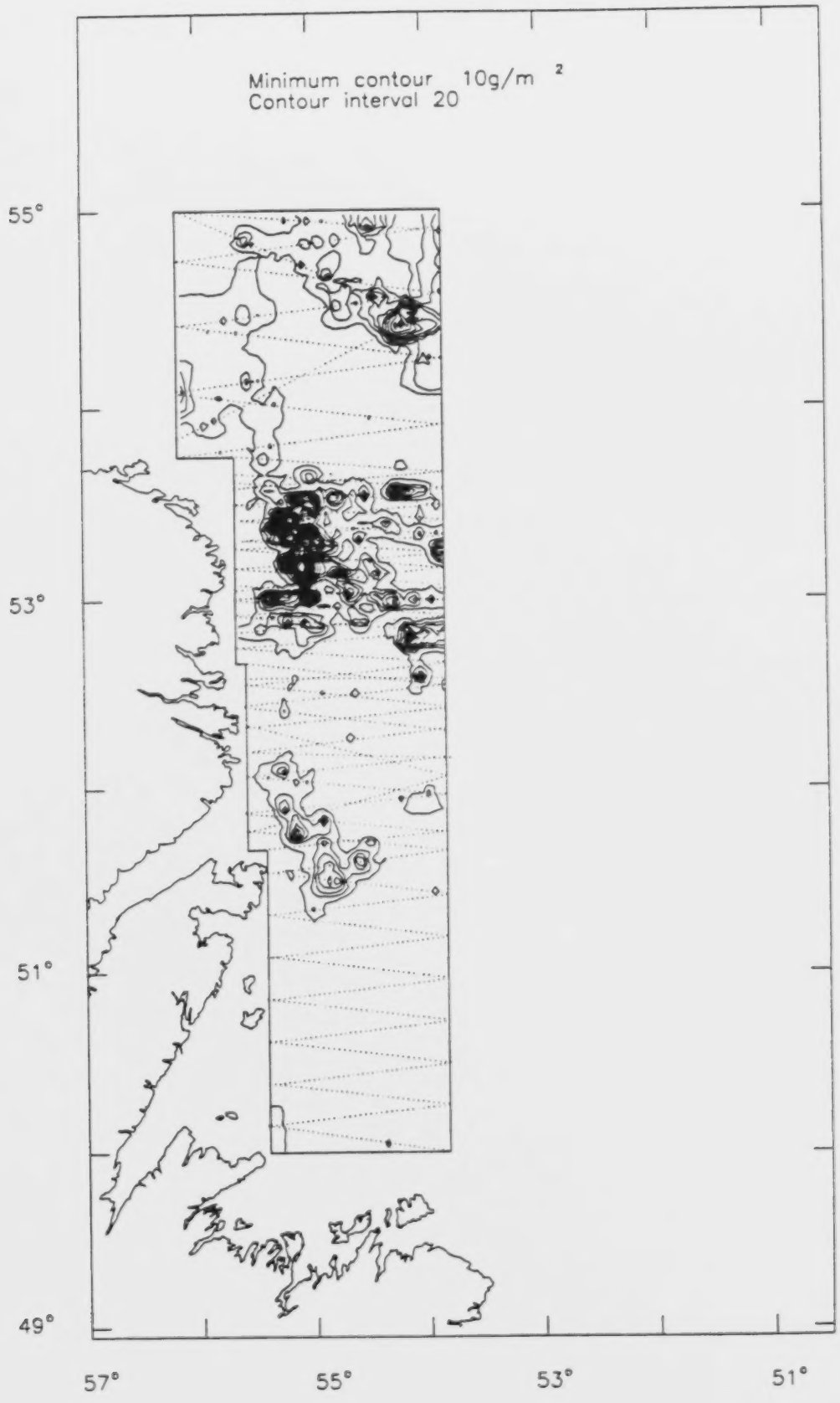

Figure 5. Acoustic capelin distribution in 1985

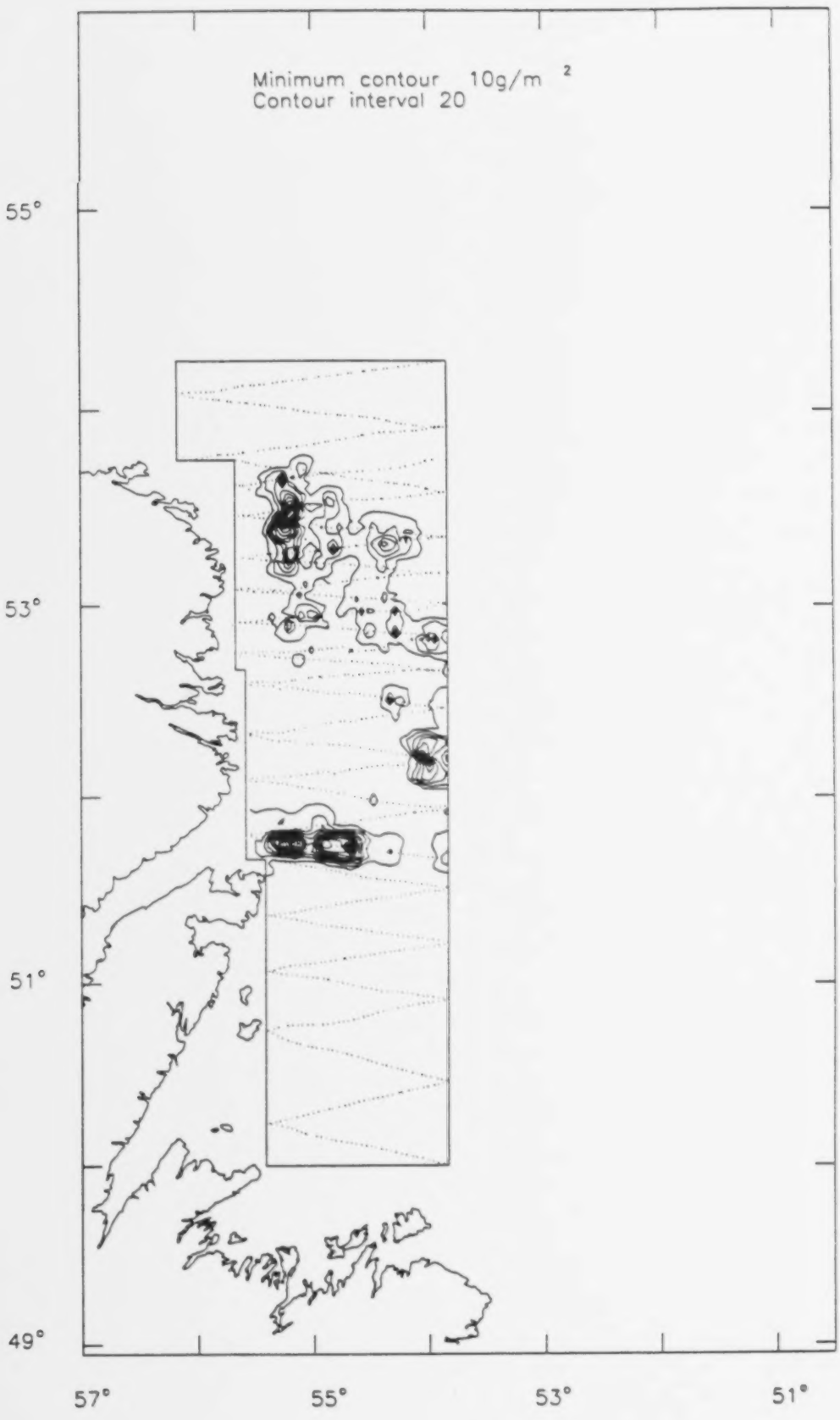

Figure 6. Acoustic capelin distribution in 1986

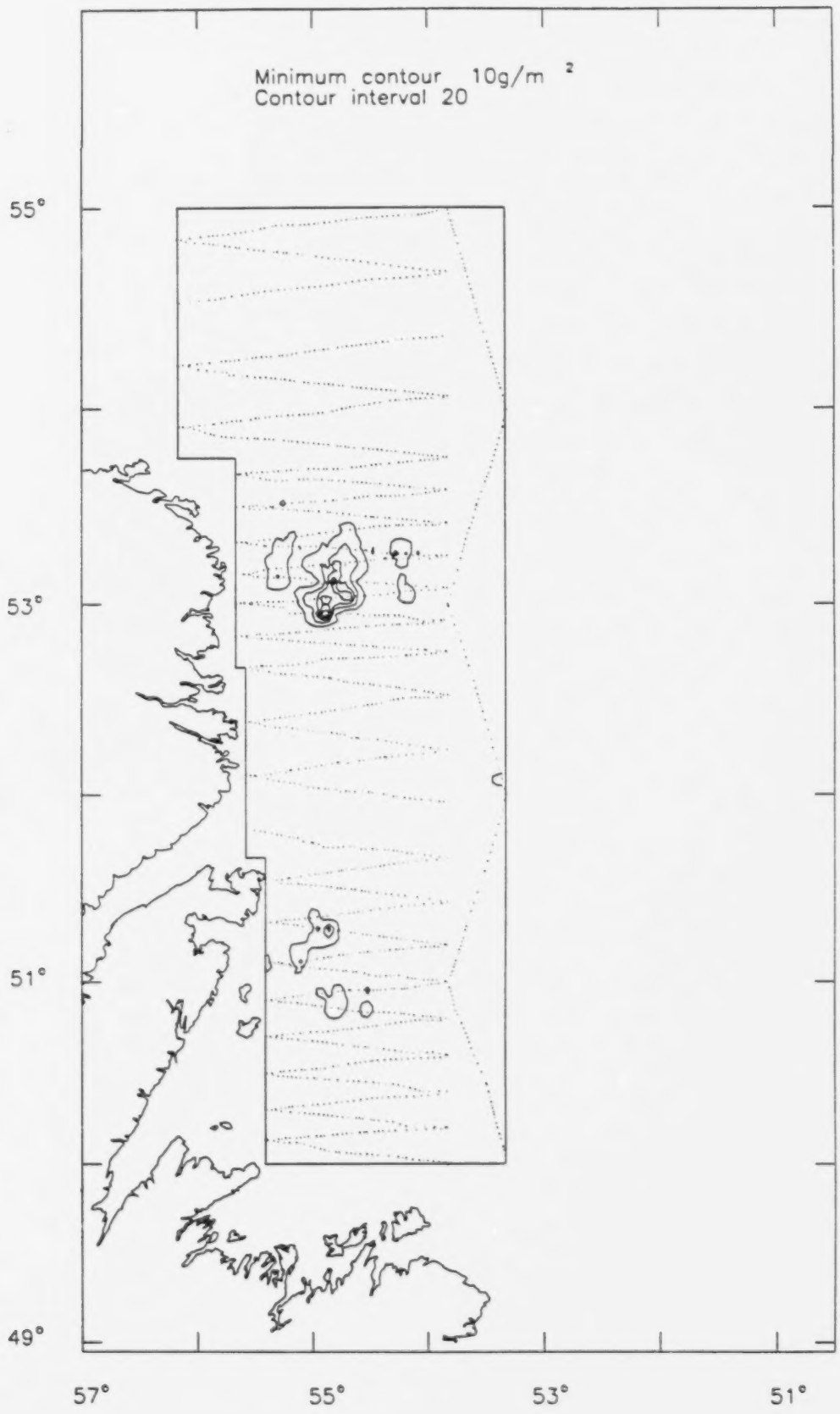

Figure 7. Acoustic capelin distribution in 1987

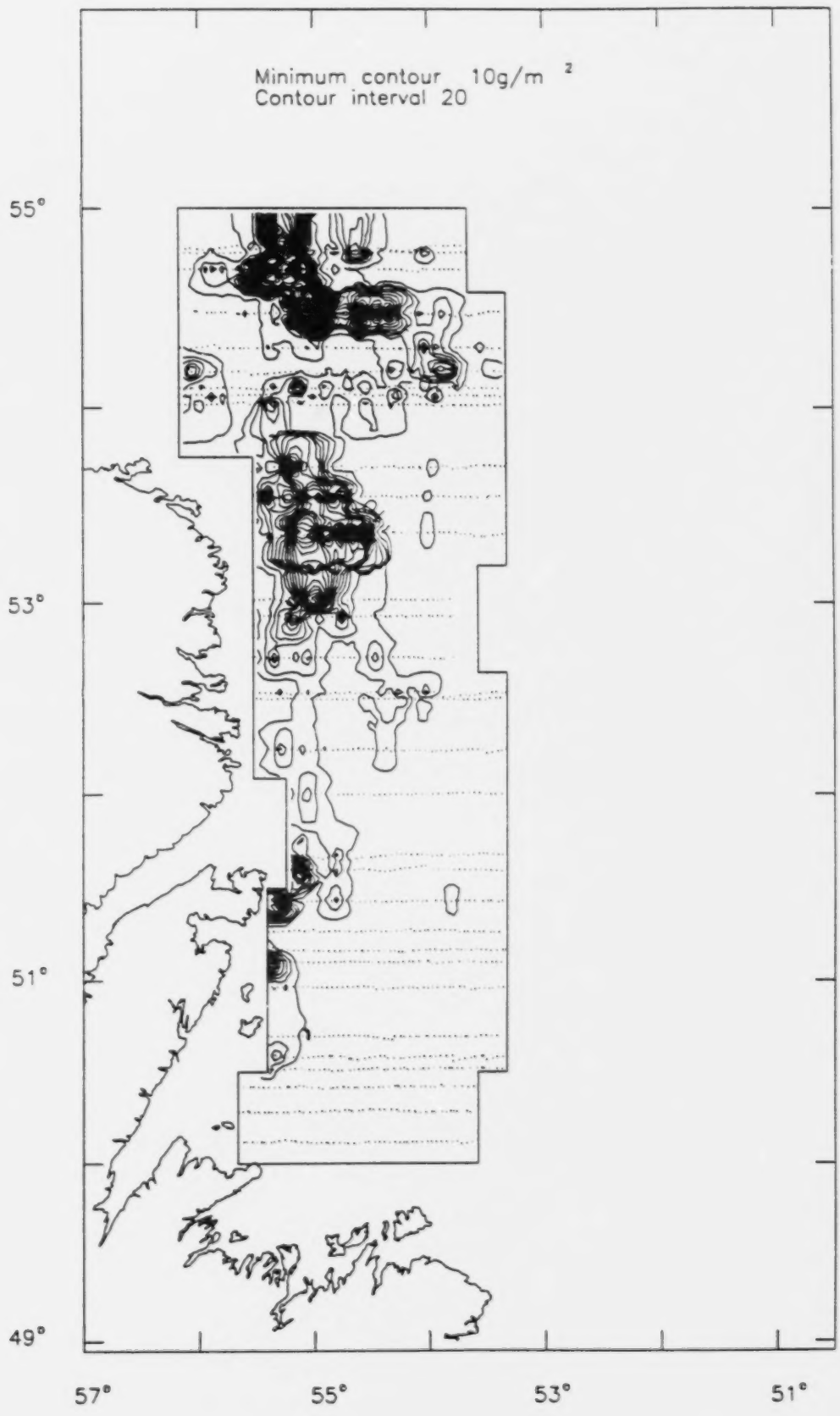

Figure 8. Acoustic capelin distribution in 1988

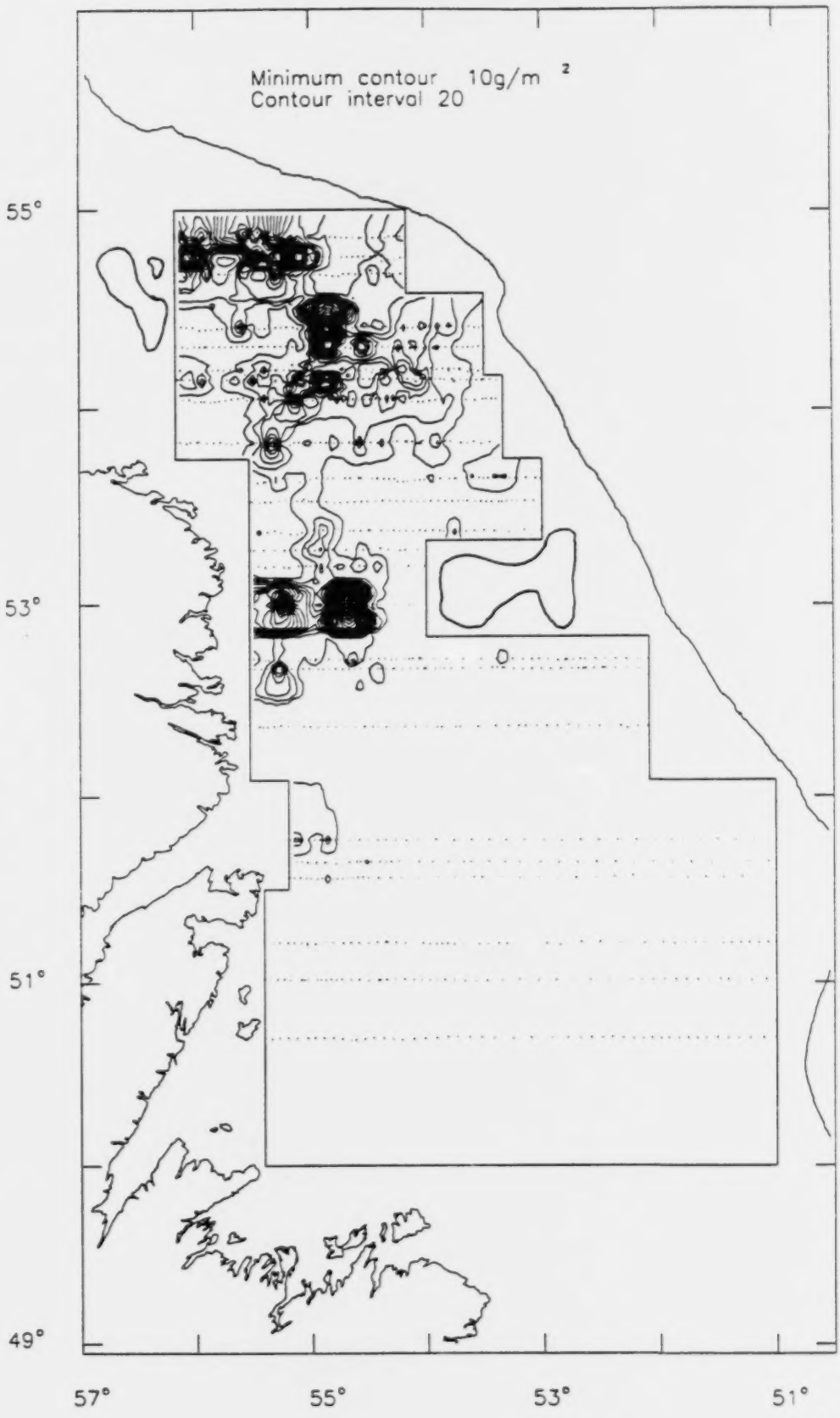

Figure 9. Acoustic capelin distribution in 1989